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ABSTRACT

Based on the premise that the production strategy and the production approach have a strong impact on quality courseware development, a survey was conducted in 1987 to evaluate the development processes used for computer-assisted instruction curriculum materials. Questionnaires were sent to 64 institutions of higher education in England, the Federal Republic of Germany, the Netherlands, Switzerland, and the United States. There was a response rate of 50% for nonprofit institutions and 4.8% for profit organizations. Analyses of the data indicated that: (1) most of the respondents include concepts, ideas, and procedures of instructional (system) design in courseware development, but the procedures used have little in common; (2) most of the respondents utilize a team strategy for courseware development; (3) the respondents identified software engineering, the consideration of instructional and/or pedagogic concepts and ideas, and the production strategy as options that may discriminate between good and bad courseware; (4) the cyclic, iterative team strategy is regarded as appropriate by the respondents, most of whom reported no experience with other production systems; (5) respondents considered PASCAL, C, BASIC, machine/assembly language, and Logo to be the most important all-purpose languages for courseware development; (6) review and evaluation forms are the most important methods used by the respondents to determine software quality; and (7) the most important areas of software use after the natural sciences are economics and languages. The data are presented in 31 tables, and five references are provided. (RP)

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DEVELOPMENT OF COMPUTER-ASSISTED INSTRUCTION CURRICULUM MATERIALS

RESULTS OF A SURVEY

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Seon in August, 1987

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A B S T R A C T

Though the development of courseware (i.e. instructional software) and its implementation in schools (especially Universities and Colleges) was initiated in the U.S.A. in the late 1950s and early 1960s, the overall quality of courseware is still mentioned to be questionable by many authors. A bunch of reasons contribute to this situation.

We believe that the **production system** (encompasses the production strategy and the production approach) has a **strong impact** on quality courseware development. One method to explore production systems for courseware development is the establishment of questionnaires which are sent to institutions which develop and/or use courseware.

This survey was started in January 1987 and was called "Development of CAI Curriculum Materials". It was established within a research study (dissertation) to explore the question of (large scale) quality courseware development.

The purpose of this survey was the evaluation of quality courseware development. The survey contained five parts: **General** indications, questions of general interest due to **instructional factors**, questions for **developer**(s) of CAI materials, questions for **user**(s) of CAI materials, and finally some additional indications. Part two trough four were the main sections of this research instrument.

64 institutions in England, the Federal Republic of Germany, the Netherlands, Switzerland, and the U.S.A. were addressed. Unfortunately, only two profit institutions returned a completed questionnaire. This makes a response rate of only **4,8** per cent for **profit** organizations! On the other hand, **50** per cent of all **non profit** organizations responded and returned a completed questionnaire. The survey revealed that profit organizations - especially in Europe - did not like and/or appreciate questions about their (internal) procedures. The overall response rate was **28,1** per cent for the total sample including the profit organizations which returned the survey uncompleted.

Nevertheless, the survey reveals **interesting results** in various fields of interest: About instructional factors and their integration in courseware development, main activities of courseware development, instructional design of courseware, evaluation of production strategies and approaches, discriminating (quality) factors for courseware development, assessment of experiences with other production systems, aspects of authoring courseware, feedback information from users about the quality of courseware, courseware development and use in the future, and finally about aspects of courseware use.

Moreover this report will offer an **interpretation** of results combined with **conclusions** and a final **summary**.

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1 INTRODUCTION

Though the development of courseware (i.e. instructional software) and its implementation in schools (especially Universities and Colleges) was initiated in the U.S.A. in the late 1950s and early 1960s, the overall quality of courseware is still mentioned to be questionable by many authors. A bunch of reasons contribute to this situation.

We believe that the **production system** (= **production strategy** and **production approach**) has a **strong impact** on quality courseware development. One method to explore production systems for courseware development is the establishment of questionnaires which are sent to institutions which develop and/or use courseware. This survey was established within a research study (dissertation) to investigate the question of (large scale) quality courseware development.

A first, limited survey was started in December 1986 addressing fourteen institutions of Higher Education in the U.S.A.[1] This questionnaire was based on a survey by Potts[2] in 1979. Besides some specific research targets, this questionnaire served as a test instrument for our own survey called "Development of CAI Curriculum Materials" which was started in January 1987 addressing 64 institutions in England, the Federal Republic of Germany, the Netherlands, Switzerland, and the U.S.A.

The next chapters offer an overview of the results, an interpretation together with conclusions, and a summary.

2 PRESENTATION OF THE RESULTS

a Introduction

The purpose of this survey was the evaluation of quality courseware development. The questionnaire contained five parts:

1 **General** Indications;
2 Questions of General Interest Due to **Instructional Factors**;
3 Questions for **Developer(s)** of CAI Materials;
4 Questions for **User(s)** of CAI Materials; and finally
5 Additional Indications.

Part two trough four are the main sections of this questionnaire.

For the purpose of this survey, the following definitions were used for the terms listed:

Courseware/CAI curriculum materials:
In instructional design all the materials which are used in courses and/or training are called courseware. Whenever the computer is the delivery device, courseware means to be the software delivered through the computer including (all the) worksheets, -books, (teacher's and students') manual(s), and so forth.

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[1] U. Karrer, Results of a Follow-up Survey of CAI Development in Selected Institutions of Higher Education, Seon (Working Paper), 1987

[2] A. Potts, A Study of Factors Affecting the Success of Computer-Assisted Instruction in Selected Colleges and Universities, Diss. (Florida Atlantic University) Boca Raton, 1979 (UMI No. GAX79-25611)

Synonyms often used are educational software, instructional software, CAI (curriculum materials), CAL, CBI, CBL, and so forth. We are aware of the fact that some authors make distinctions between some of these acronyms and their application in (research) studies. For the purpose of this survey, it is not necessary to make any of these distinctions as we do not focus on classifications of courseware and its implementation in courses and/or training.

Instructional factors:
These are factors which affect appearance and effectiveness of courseware, that is the quality of learning.[3]
Synonyms are called "instructional (software) design principles", "instructional characteristics", "basic criteria for the design and production", and so forth.

(Instructional) effectiveness:
Effectiveness means being able to bring about the result(s) intended. In instruction, the results are defined through the instructional objectives and/or targets. An example of such an objective may be: This lesson will teach you to determine whether a painting is of Classic, Impressionist, or Modern periods.

Production system:
A courseware production system may be defined as the (entire) set of activities beginning with vague ideas about the concepts to be taught and ending with finished materials in the hands of users.[4] A production system is based on a **strategy** and an **approach** to develop courseware.

Production approach:
The term production approach encompasses the **way** and **process** of production and focuses on the application of the software life cycle and the instructional design models to courseware development.

Production strategy:
Strategy means the **combination** of **resources** to **setup** and **run** a production process of courseware development. Questions addressed in this context are decisions about manpower and required skills, hardware and tools used for development.

b About the Respondents

The survey was sent to 64 institutions in England, the Federal Republic of Germany, the Netherlands, Switzerland, and the U.S.A. Tables 1 and 2 show the number of surveys returned and characterize the institutions which completed the survey. We understand "profit organizations" to be institutions which work on their own with no (external) funds and grants from foundations and similar organizations for courseware development. "Non profit organizations are all the others (which receive funds and grants).

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[3] For further details see: St. Alessi, St. Trollip, Computer-Based Instruction, Methods and Development, Englewood Cliffs (NJ), 1985, p. 66

[4] A. Bork, Production Systems for CBL, in: Walker & Hess (Eds.), Instructional Software, Principles and Perspectives for Design and Use, Belmont (CA), 1984, p. 96

Description of the institutions addressed	No. of surveys sent away	No. of surveys returned	Response rate in per cent
England:			
- Non profit organizations	5	3	60,0 %
- Profit organizations	7	1[5]	14,3 %
Total country	12	4	33,3 %
Federal Republic of Germany:			
- Non profit organizations	0	0	-
- Profit organizations	16	4[6]	25,0 %
Total country	16	4	25,0 %
Netherlands:			
- Non profit organizations	2	1	50,0 %
- Profit organizations	0	0	-
Total country	2	1	50,0 %
Switzerland:			
- Non profit organizations	2	2	100,0 %
- Profit organizations	3	0	0,0 %
Total country	5	2	40,0 %
U.S.A.:			
- Non profit organizations	13	5	38,5 %
- Profit organizations	16	2	12,5 %
Total country	29	7	24,1 %
Non profit organizations	22	11	50,0 %
Profit organizations	42	7	16,7 %
Institutions which mainly...			
- Develop courseware	-	8	-
- Use courseware	-	1	-
- Develop and use courseware	-	3	-
- Focus on other areas[7]	-	6	-
T O T A L	64	18	28,1 %

TABLE 1: Number of surveys sent away and returned

Twelve institutions develop courseware (Eight only develop courseware, three develop and use it, one is a publisher). Table 2 shows the number of staff working for courseware development in these twelve institutions.

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[5] We got this survey back with the information that the institution would be unable to answer the questions in detail.

[6] The four institutions sent the questionnaire back with the information that they would be unable to assist with the survey, for instance, because the answers would impart internal know how and explain too much to interested people outside the organization!

[7] These are publishers, institutions which mainly develop programmed instruction (books), and/or focus on continuing education of teachers, and so forth.

Number of staff	No. of developers Profit	Non-Profit
Less than 10 persons	1	4
10 - 50 persons	1	2
50 - 100 persons	0	2
More than 100 persons	0	0
Varies with projects	0	1
No answer	0	1
Total[e]	2	10

TABLE 2: Number of staff working in the institutions which develop courseware

The addresses for the survey were gathered from literature (books, articles) and catalogs (of institutions which publish courseware). The survey was sent away in January 1987 giving time to return it completed until mid of February 1987.

It seems that profit organizations - especially in Europe - do not like and/or appreciate surveys, i.e. questions about their internal procedures.[f] This makes an overall response rate of 28,1 per cent. Subtracting the five profit organizations who refused to fill out the survey, a response rate of only 20,3 per cent was realized for the surveys which were returned completed. Cohen & Manion state that a well-planned postal survey should normally obtain approximately 40 per cent response on the original dispatch.[10] This target was not realized by the survey taking in account all respondent groups! **However, if only NON PROFIT ORGANIZATIONS are considered, a response rate of 50,0 per cent was realized.**

To conclude, eleven non profit organizations and two profit organizations returned the questionnaire completed. The thirteen institutions make 100 per cent in indications and results described in the following subchapters.

c Instructional Factors

The first question on instructional factors was used to determine if the respondents agree on a basic list of such factors identified from literature. The possible answers were: Yes; No; ? (= needs clarification, not enough information).

[e] One out of the thirteen respondents only uses courseware and therefore has not to answer these questions focusing on courseware development.

[f] Most of these institutions mentioned that the answers to this survey would give too much insights into the company's procedures and organization.

[10] L. Cohen & L. Manion, Research Methods in Education, 2nd Edition, London, 1985, p. 111

	Yes	No	?
A) Factors which affect the effectiveness and/or the quality of instruction (What to Whom):	-	-	-
1) Identify and consider the **target population.**	100,0	0,0	0,0
2) State/Indicate **objectives** and **goals** (except with little children).	83,4	8,3	8,3
3) Give **directions/cues/prompts** which have to be available all the times.	41,7	25,0	33,3
4) Use **motivation** and **stimulating** techniques.[11]	75,0	0,0	25,0
B) Factors which affect the outward appearance of the courseware (HOW: Manual of Style):	-	-	-
5) The courseware must have a **visible structure.**[12]	75,0	8,3	16,7
6) Provide quality **interaction.**[13]	91,7	8,3	0,0
7) Put the **user** in control.[14]	66,7	25,0	8,3
8) Modes of presentation I: Information texts should be **clear** and **short.**[15]	83,3	0,0	16,7
9) Modes of presentation II: Use (vivid) graphics, color and sound (only) for IMPORTANT information.[16]	66,7	16,7	16,7

The two non profit institutions agreed on all instructional factors to be necessary while not all of the non profit organizations fully agreed on all factors.

30,7 per cent believe that these instructional factors[17] represent a good list to consider in the development of courseware. 61,6 per cent are of the opinion that there are some **other** factors which should be considered to develop quality courseware. 7,7 per cent did not answer the question. Table 3 gives an overview of additional factors which were mentioned by the respondents.

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[11] This means: Benefits of the program are to tell when introducing it to the learner; work with curiosity; secure the attention of the learner.

[12] This means a transparent man-machine-interface, consistent commands, and so on.

[13] This means: Asking frequent questions (especially open questions), judging responses, and giving feedback.

[14] This means: A control over the structure, menus, and branching which is based on the learner's performance.

[15] See factor no. 6: Interactivity structure.

[16] This means: Not to use overly these means (especially graphics); Use them for conveying complex and important information after the rule "A picture is worth a thousand words".

[17] Remind the definition of instructional factors: Factors which affect appearance and effectiveness of courseware materials.

Additional Factors	No. of statements
- How is it used in class rooms? (The instructional setting/implementation environment is critical to outcomes.)	3
- Apply media-specific features (movement, answer, feedback)	2
- Timing factor as good indicator of user's problems	1
- Factors (can) depend on type of courseware	1
- Should be exploratory, not didactic	1
- Move towards open-endedness	1
- The use of windowing techniques	1
- The use of user friendly input devices such as the mouse	1
- Printed materials associated with CAI	1
- Content is important, too	1
- Is the computer the best media for delivery?	1

TABLE 3: Additional instructional factors which may be included in a list of basic instructional factors

Another question focused on the integration of (a basic set of) instructional factors into the process of developing courseware. It was asked if and why the instructional factors should be integrated into the production approach - independent from the approach applied by the respondents. Table 4 was developed from the answers to this question.[18]

Arguments	No. of institutions
Yes, instructional factors have to be considered in courseware development:	
- No arguments mentioned	3
- Research demonstrates that instructional factors are crucial in the design of effective CAI materials.	1
- It diminishes the cost and the time needed as well as enabling to enrich the new materials.	1
- To allow max. opportunity for learning to take place	
- Represented by excellent teachers (SME)	1
- That is our business: help teachers educate students. Our practice and content presentation must match current practice.	1

[18] Only developers of courseware answered this question. Therefore, only 12 institutions had to respond.

Arguments	No. of institutions
No strong opinion: I would consider anything positive and this is a positive factor	1
No, instructional factors have not to be considered in courseware development:	0
No answer	4

TABLE 4: Arguments for and against the integration of instructional factors into the production process

d Main Activities of Courseware Development

The first question of the subchapter main activities of courseware development focused on the **subjects** of courseware developed by the respondents. It is interesting to see that 50 per cent cover all three areas (Natural Sciences, Social & Economic Sciences, and Humanities & Languages). 25 per cent have activities in two areas; 16,7 per cent in one area only. One respondent has its main activity in **another** area (Industrial Technical Training).

Table 5 shows the importance of subjects related to the number of respondents which develop courseware in that subject.

Subjects	Number of statements
Chemistry	7
Physics	7
Biology	6
Mother Tongue Language	6
Economics	5
Mathematics and Statistics	5
Computer Science	5
Education	4
Foreign Language(s)	4
History and Politics	4
Engineering	3
Management	2
Psychology	2

Subjects	Number of statements
Art(s)	1
Early learning letter and number identification	1
Environmental Studies	1
Geography	1
Industrial Training	1
Medicine	1
Music	1
Philosophy	1
(General) Problem Solving)	1
Sociology	1

TABLE 5: Importance of subjects in which courseware is developed

It is interesting to see that, after the Natural Sciences (subjects such as Chemistry, Physics, Biology, and Mathematics), the Social & Economic Sciences and the Languages (subjects as Mother & Foreign Languages, Economics) are important areas of courseware development.

Table 6 gives an overview of the CAI strategies (types of courseware) chosen by developers. The importance percentages show the relative importance of a courseware strategy related to the other strategies.

Type of courseware	Developers Number	Developers Percentage	Importance percentages
Tutorials	7	23,4 %	32,10 %
Drill & Practice	3	9,9 %	6,02 %
(Instructional) Games	5	16,7 %	12,04 %
Simulations	9	30,0 %	30,38 %
Tools	5	16,7 %	10,90 %
Logo Tools	1	3,3 %	8,56 %
Total	30	100,0 %	100,00 %

TABLE 6: Relation between courseware strategies, developers and importance percentages of courseware strategies

e Instructional (System) Design (ISD)

One important aspect in courseware development is the **instructional design.** Table 7 shows the models and procedures applied in relation to the number of developers working with these models and procedures.

Type of model(s)	Short description of the model(s)	No. of developers applying the model
Project and subject specific model(s)	a) Depending on applications; design is specific to the objectives and the audience.	3
	b) It is up to the teachers/ SME[19] to choose an appropriate pedagogic design model.	2
Institution specific model(s)	a) The use of the mouse and multiwindowing techniques in the courseware. The use of worksheets in combination with a simulation program.	1
	b) 1) Initial steps 2) Prototype steps 3) Extended phase 4) Dissemination	1
	c) Team approach; each project has its own project management; iterative process; encompasses: 1) Preplanning phase(s); 2) Training activities; 3) Pedagogical design; 4) Visual/Graphic design; 5) Implementation; and 6) Review/Evaluation and revisioning.	1
	d) CIC model:[20] Basis of the model lies in a large team that reflects a combination of expertise in hardware, software, the curriculum, and schools.	1
No model(s)	a) Because tool environment is defined on its own.	1
	b) Because models are too confining - do not allow creativity or use of changing technology.	1

TABLE 7: Instructional design models applied by the institutions developing courseware

[19] SME = subject matter expert = content specialist

[20] Deryl M. Watson, Developing CAL - The Computers in the Curriculum (CIC) Model, in: EURIT 86, pp. 225 - 233

One institution omitted this question without indicating a reason and/or statement.

f Evaluation of Production Strategies

Some questions encompassed the production strategies applied by the respondents. A first question focused on the chosen production strategy itself. Table 8 was developed from the answers to this question.

Applied production strategy	No. of institutions Profit	Non Profit	Total
Team based	2	6	8
Individual based		1	1
Team and individual based		2	2
Others: Individual SME with support as needed from central group		1	1
Total	2	10	12[21]

TABLE 8: Applied production strategies

Twelve institutions develop courseware. One of these only applies the individual strategy and therefore did not answer the following question which focuses on the team members. Table 9 shows how the institutions put together their teams.

Team members	No. of institutions Profit	Non Profit	Total
Content specialist (SME)/Good teachers	2	8	10
Instructional designer[22]	1	5	6
Graphics designer	1	3	4

[21] One out of the thirteen respondents only uses courseware and therefore has not to answer these questions focusing on courseware development.

[22] This term was mostly used by American respondents.

Team members	No. of institutions Profit	Non Profit	Total
Educational Technologist/Engineer[23]		2	2
Programmer: - Student - Professional - Student and Professionals	2	3 4 1	3 6 1
Systems Analyst		3	3
Project Manager/ Supervisor/Editor		3	3

TABLE 9: Skills/Capabilities of team members

There are three institutions (out of twelve) which produce courseware individually. One of them only applies the individual strategy, the others apply both - the individual and team strategy.

Table 10 describes the capabilities and/or skills of these individuals. Multiple answers were allowed.

Capabilities/Skills	No. of institutions
Had prior computer training or had programming experience	3
Had in-service courses	1
Was a system analyst or programmer and could call on SME	3
Was a student	0

TABLE 10: Skills/Capabilities of individuals

An interesting question focused on the satisfaction of production strategies related to outcomes - the courseware materials. Table 11 shows the results of this question.

Applied production strategy	No. of institutions Profit	Non-Profit
Institutions that only develop with teams:		
- Team produced	1	4
- Individually produced	0	0
- No answer	1	2

[23] This term was mostly used by European, especially English respondents.

Applied production strategy	No. of institutions	
	Profit	Non-Profit
Institutions that only develop with individuals:		
- Team produced	-	0
- Individually produced	-	0
- No answer	-	1
Institutions that develop with both strategies (individually and team)		
- Team produced	-	1
- Individually produced	-	0
- Depends on project (winners and losers on both)		1
- No answer	-	0
Other strategy is even more satisfactory:		
- SME with support as needed from central group	-	1
Total of institutions	2	10

TABLE 11: Satisfaction judgement for production strategies

g Advantages and Disadvantages of Production Strategies

A large list of advantages and disadvantages to develop courseware by (a) team(s) was mentioned:

- Advantages:
  - Quality control (regarding instructional design principles and software engineering);
  - Easier if staff with specialists than individual(s) with all necessary skills;
  - All skills available;
  - Faster production;
  - Brainstorming possibilities, Peer group discussion;
  - Time and test criteria are more explicit;
  - A collection of experience (through the specialists); and
  - More expertise can be applied in the concept being taught.

- Disadvantages:
  - Synchronization overhead;
  - Usually more time consuming;
  - No personal identity with the ongoing project;
  - Expensive; and
  - Painful process.

The following aspects were mentioned referring to the individual strategy:

- Advantages:
  - More creative;
  - Easier to make changes from original design;
  - If an individual has all the skills, development can be more rapid;
  - The high demands on individuals; and cheaper.

- Disadvantages:
  - Limited possibilities and
  - Bad quality control (instructional design and software engineering).

h Evaluation of Production Approaches

Another question focused on the capability of the production approach to integrate the instructional and pedagogic concepts, ideas, and know how in the production process of courseware development. Table 12 was developed from the answers given to this question.

Arguments	No. of institutions
Arguments based on **implementation environment:**	
Use of a general purpose programming language: We build new tools from our **production experience** to facilitate the production of new material.	1
Our **design system** (MacThesis) is specially designed for this purpose (integrating the instructional know how in the production process).	1
Arguments based on **production approach** (process phases, stages):	
In our department model, we have a **review test** (both peer [content] and technical [design, etc.]). The review form captures the content questions and some design questions. Our technical review is done by staff. Peer review by content specialist (University professors) across the USA.	1
Arguments based on **production strategy** and production **approach:**	
The **instructional designer** plays the most important role, but so do staff training, newsletters and handouts, faculty demonstrations.	1
Through **team strategy**, involvement of specialists (good teachers), iterative review process/evaluation	1

Arguments	No. of institutions
Miscellaneous:	
No; I cannot examine and rate our design and development model	1
Question not understood	1
No answer	5

TABLE 12: Evaluation of applied production approaches by the respondents.

i Use of Instruments, Methods, and Tools for the Requirement and Design Phases of Courseware Development

Which instruments, methods, and tools are used for the requirement/design phase(s) of courseware development. Table 13 gives an overview of these instruments applied by profit and non-profit organizations.[24]

Instruments/Tools for the requirement/design phase	No. of institutions			
	Profit	Non-Profit		
	Team strategy	Production strategy Indiv.	Team	Both
SADT/SA			1	
Structure Charts/ Structured Design			1	1
Flowcharting			3	1
Storyboarding	1		2	1
Brainstorming/Editing on the computer/Prototyping on machine	1		2	1
Institution specific instruments/methods and tools - Lisa Pascal toolbox/Macthesis				1
- "Script"-technique			1	
Depends on the team			1	
No answer		1	1	

TABLE 13: Instruments, methods and tools applied for the requirement and design phases of courseware development

Eight out of twelve developers not only use "standard instruments" such as SADT, Flowcharting, Storyboarding, but employ special in-

[24] Multiple answers were allowed.

struments, too. Table 14 describes these special instruments and/or methods.

Instrument/Method:		No. of institutions
Name	Short description	
Internal prototyping method	Not a common tool; new tools are tried out.	1
"Script"-technique	Not a common tool; twenty years of experience; very effective.	1
Dan Bricklin's DEMO program (for IBM PCs and compatibles)	DEMO supports the design by giving the opportunity to design screens of a prototype without generate code ("vaporware generator"). Helps to outline the faculty member's ideas but it does not handle graphics and is just an editor.	2
Lisa Pascal toolbox and authoring system	Library system on one hand and MacThesis as an authoring tool on the other hand.	1
"Depends on team(s)"	We have and continue to be against authoring systems. Design must be the best (for objectives and target group), not compromised by construction barriers.	1
OPU and comic strip, library system	No common tool(s); provide appropriate means to present ideas.	1
Brainstorming on the machine	(No further description was given.)	1

TABLE 14: Specific instruments/tools employed by courseware developers for the requirement/design phase

j Discriminating (Quality) Factors for Courseware Development

Which activities (i.e. aspects of the software life cycle, the software project management as well as general requirements and guidelines to be fulfilled for quality courseware development) can be **discriminating** between good and bad courseware related to the production system? Tables 15 through 24 were developed from the answers to the questions in this subchapter.

The basic question listed **seven** areas which could discriminate between good and bad courseware (as outcome of the production system). Table 15 gives an overview of the number of areas which were considered to be discriminating by the respondents.

Number of main areas seen as discriminating	No. of institutions Profit	Non-Profit	Total
Six areas of factors	1	1	2
Five areas of factors	0	2	2
Four areas of factors	0	2	2
Three areas of factors	0	0	0
Two areas of factors	1	2	3
One area of factors	0	2	2
No answer	0	1	1

TABLE 15: Number of areas stated to be discriminating between good and bad courseware

But what are the activities, i.e. main areas, which discriminate most between good and bad courseware development related to the production system. Table 16 shows the answers to this question.

Main areas	No. of institutions Profit	Non Profit	Total
Software life cycle	2	9	11
Consideration and integration of pedagogical and/ or instructional know how in courseware development	1	6	7
Production strategy/Staff	1	6	7
Activities of the software project management	1	3	4
Methods/instruments and tools used	1	3	4
Programming language	1	3	4
Other (specify) - What to publish	1	0	1
No answer	0	1	1

TABLE 16: Judgement of areas which may discriminate between good and bad courseware

The software life cycle was rated most positively (11 times!).

Table 17 shows how the phases within the software life cycle were rated that may contribute most to quality courseware development.

Phases of the software life cycle	No. of institutions		
	Profit	Non Profit	Total
Preplanning phase	0	1	1
Requirement/definition phase	0	2	2
Design phase	1	5	6
Coding	0	2	2
Evaluation incl. field testing	0	5	5
Other (specify)			
- Iterative process	0	2	2
- All phases do discriminate to greater or lesser extent.	1	3	4

TABLE 17: Discriminating power of the phases of the software life cycle

Secondly, the survey revealed that the consideration and integration of pedagogical and/or instructional know how is considered to be discriminating in courseware development. Table 18 shows the open-ended answers given to this argument.

Arguments	Institutions		
	Profit	Non-Profit	Total
No further comments	1	3	4
"Important" By including educational engineer(s) in the team who supervises the design process		1	1
		1	1
Through good teachers (SME)		1	1

TABLE 18: Discriminating means within the area consideration of instructional know how

Moreover, it was claimed that the staff is a discriminating factor (seven times). Table 19 and 20 show the detailed factors within this area which may make a difference between good and bad quality courseware.

- Individually or team produced?

Strategy	No. of institutions		
	Profit	Non-Profit	Total
Both	0	1	1
Individual(s)	0	0	0
Team	1	5	6

TABLE 19: Discriminating power of production strategies

- If produced by individuals; by whom?
  One (non-profit) institution claimed that the individual and team strategy can be discriminating. Regarding the individual strategy, it was stated that this person must know a lot about programming, educational design, and has to be a content specialist.

- If produced by teams: Who may contribute most to quality courseware development?

Function/Person	No. of institutions		
	Profit	Non-Profit	Total
Content specialist	1	5	6
Programmer			
- student		4	4
- professional	1	3	4
Systems Analyst	1	2	3
Other (specify)			
- Instr. Designer		3	3
- Media specialist		2	2
No further comments		1	1

TABLE 20: Discriminating power of team functions

Table 21 gives an overview of all activities within the area "activities of the software project management" which was mentioned four times.

Activities of the SW Project Management	Institutions	
	Profit	Non-Profit
No further comments	1	
"Be a member of the team"		1
Coordination, Communication, Setting priorities, Providing recognition		1
Creative and technical direction		1

TABLE 21: Discriminating power of activities within the software project management

Four respondents claimed that the instruments, methods, and tools used for the design phase would discriminate between good and bad courseware. Table 22 was developed from the factors stated to this question.

Methods/instruments and tools employed	Institutions [25]
Storyboarding tool	1
Programming procedures	1
User friendly input devices (such as the mouse)	1
Institution specific design method	1
No further comments	1

TABLE 22: Discriminating methods/instruments, and tools employed by institutions

Four respondents mentioned that the area "programming language" may make a difference. Table 23 shows the answers.

Programming Language	Institutions	
	Profit	Non-Profit
Choosing the appropriate language		1
High level language		2
Authoring system/language	1	

TABLE 23: Discriminating power of programming/ authoring languages

Some respondents stated that the programming language would be irrelevant, (even) unimportant to develop quality courseware.

Courseware development is an **imaginative** and **creative** process. But this does not mean that there are not factors and requirements which can **support quality courseware development.** Our final question on discriminating factors focused on such aspects, factors, and requirements which may ensure quality courseware development?[26] The respondents could answer this question in a **free format.** Table 24 was developed from the results to this question.

[25] One (of the four) institutions mentioned two instruments.

[26] The integration of instructional factors into the production process was mentioned in the survey as a possible example.

Aspects, factors, and requirements that enhance courseware development to greater extent	Institutions		
	Profit	Non-Profit	Total
By principles, methods, instruments, and tools		1	1
Combined work of SME and CAI specialist		1	1
Educational theory, explicit educational objectives, focus groups with end users prior to production, extensive testing internally.		1	1
Evaluation instrument(s)		1	1
Professional judgement	1		1
Use good, wise educational technologists/ instructional designers.		1	1
Use good teachers (SME) for the design, a team strategy, and employ an iterative approach.		1	1
No answer/No comments	1	4	5

TABLE 24: Aspects, factors, and requirements which may support quality courseware development

k Assessment of Experiences with Other Production Systems

It was asked if the respondents (already) made experiences with other production systems (strategy and approach) rather the one actually used.

A list of statements, representing experiences with other production systems, is the result of this question. Every statement stands for one institution if nothing else is mentioned.

- Due to the production strategy:
  - Faculty member (SME) working together with (student) programmer;
  - Individual as sole producer; and
  - We used the (traditional) team strategy, but apply now a support strategy (individual content specialist can have support as needed from designers, programmers, editors, graphic artists, etc.)[27]

[27] This statement comes from a publisher.

- Due to production approach:
  - Development after traditional software life cycle (Analysis, Design, Implementation, Test); and
  - ISD model.

- No, we did not make experiences with other production systems.

- No answer (7 institutions).

Five out of the thirteen institutions made experiences with other production systems (strategies and/or approaches). Table 25 resumes the advantages and disadvantages of these systems.

Previous production system(s)	Description of disadvantages
Due to the production strategy:	
- SME with (student) programmer	Problems regarding management and student programmers, software engineering resulted.
- Individual as sole producer	Team has more power than individual.
- (Traditional) team strategy (now support strategy	No matter what production system is used; we still include evaluation phases. The evaluation forms we use are not based on any (instructional) model.
Due to the production approach:	
- Development after traditional software life cycle	Cyclic, iterative approach allows for more creativity, innovative practices.
- ISD model	It is too cumbersome but has all the critical elements in the process.

TABLE 25: Description of advantages and disadvantages of other production systems

1 Aspects of Authoring Courseware

The first question in the subchapter aspects of authoring courseware covered the programming languages. It was asked which main programming languages are used for courseware development.

Programming languages	Frequency		
	Profit	Non-Profit	Total
Basic		4	4
BCPL		1	1
C	1	4	5

Programming languages	Frequency		
	Profit	Non-Profit	Total
Logo		3	3
Machine/Assembly language	1	2	3
Modula 2		1	1
Pascal		6	6
Prolog		1	1
Authoring languages/systems			
- ACE (Template editor)		1	1
- MERLIN (with telephone link for learning at a distance)		1	1
- PC Pilot		1	1
- STAF2		1	1
- TENCORE	1		1

TABLE 26: Programming languages used for coding courseware

Five out of the thirteen institutions use an authoring language and/or system to code courseware.[28] All the others only use an all purpose (high level) language to code courseware. Table 27 lists the reasons why these eight institutions do not use an authoring language and/or system.

Reason(s)	Frequency
- Authoring languages are not suitable for making simulation programs. The trend is to build libraries in a high level language.	1
- Authoring languages are (only) suitable for tutorial CAI.	2
- Does not cover our needs.	1
- End product too large and slow.	1
- Our main goals are portability and multilinguism.	1
- Too limiting and restrictive.	3

TABLE 27: Reasons why authoring languages/systems are not used.

One of the eight institutions which does not use an authoring language (up to now) was evaluating an authoring language for prototyping purposes at the time of completing the survey.

m Feedback Information from Users about the Quality of Courseware

What are the channels/means through which the developers of courseware get feedback from the users about the effectiveness and/or

[28] Some of the respondents only use an authoring language and/or systems; other use it beside all purpose (high level) languages.

quality of courseware developed? Table 28 was developed from the answers to this question.

Channels/Means of feedback	Frequency		
	Profit	Non-Profit	Total
Documents:			
- Field testing	1	1	2
- (Formative and summative) evaluation and review forms	1	6	7
- Questionnaires		3	3
- Reports		2	2
Computer based tools:			
- On line collection of information through local area network		1	1
Personal contacts:			
- Visits		1	1
- Interviews		1	1
- Trouble calls from users		1	1
- Hot line		1	1
- User meetings		1	1

TABLE 28: Channels/Means of feedback from users

But is this feedback information about effectiveness of courseware reused for integration in new and ongoing courseware development? Table 29 was developed from the answers to this question.

Methods for integration of feedback information	Frequency		
	Profit	Non-Profit	Total
- Analyzed by team(s).		1	1
- Results are monthly used for existing design review (Based on LAN).		1	1
- Reaction of production teams/By making improved versions of the programs		2	2
- Throughout the maintenance stage.		1	1
- Used on trials to improve drafts.		1	1
- Used in future edition of same package, because feedback is specific to the package.		1	1
- No answer	2	3	5

TABLE 29: Methods for integrating feedback information in (new and ongoing) courseware development

n Courseware Development and Use in the Future

The following trends were seen by the respondents for courseware use in the future. Every statement stands for one institution if nothing else is mentioned.

- Due to the situation in the instructional/training media market:
  - CAI will stay a niche product; it is just one media - to compare with the situation of programmed instruction (PI);
  - CAI as complementary instruction for adults;
  - Widespread use of CAI in industry, school and home;
  - Increasing use in "drill" exercises;
  - Instruction is not the role of the computer; learning is. Computer programs will become more open, exploratory, supporting with information on call as user needs it. Short programs to visualize simple concepts will also be useful;
  - Use of CAI as supportive instrument in instruction; and
  - (Hope for) Better quality (2 respondents).

- Due to the type of courseware offered on the market:
  - More tool software (3 respondents);
  - Less tutorial software (2 respondents);
  - Less drill software;
  - More simulations;
  - More database applications in instruction;
  - Interfacing with business and other generic packages for specific purposes;
  - The integration of simulation and tutorial types of software (long run); and
  - Movement from skill to concept learning.

- Due to technical progress:
  - Increase in use of high resolution color graphics and digital audio;
  - The use of multi-windowing techniques including parallel animation and graphical registration on microcomputers which can support those techniques (using a 68000 processor) (short run); and
  - Integration with video disk and extended data bases.

- Due to financing and support of CAI:
  - Continuing development with the help of grants or other funds; possibly by independent businesses.

Which trends do the institutions see for courseware development? Which tools will be available to assist courseware development on a short, medium, and long time range? The respondents could indicate their ideas based on a given list. Table 30 gives an overview of the answers.

Tools	Time ranges				
	short	medium	long	Misc.	Total
Isolated software tools	3			1	4
Tools to support the software development life cycle in its entirety		2	2		4

Tools	Time ranges short	medium	long	Misc.	Total
Tools to assist with software specification, design, and testing, as well as with management of projects	2	3	1	1	7
Development tools that permit the rapid construction and modification of system prototypes.	2	2	2	2	8
Tools and software of artificial intelligence			3		3
No answer		5			5

TABLE 30: List of tools to assist courseware development in the future

o Aspects of Courseware Use

The first question of the subchapter aspects of courseware use focused on the subjects in which courseware is used by the respondents.

Two of the four user institutions have courseware packages in all three areas (Natural Sciences, Social & Economic Sciences, Humanities & Languages), one in two areas (Natural Sciences and Social & Economic Sciences), and one only in Natural Sciences.

Table 31 shows the importance of subjects related to the number of respondents which use courseware in that subject.

Subject:	Frequency of Responses
Biology	3
Chemistry	3
Economics	3
Physics	3
Computer Science	2
Education	2
Foreign Language(s)	2
History and Politics	2
Mother Tongue Language	2
Management	2
Art(s)	1
Engineering	1
Finance	1
Mathematics and Statistics	1

TABLE 31: Subjects for which courseware is used in institutions

One institution acquires all courseware on the market. One of the institutions is developing nearly all courseware packages on its own. Two institutions have two or even three sources where courseware is acquired (from the market, produced within the institution, and from public domain organizations).

Moreover, it was asked if present plans include an expansion, curtailment or maintaining the status quo of courseware use. Two institutions want to expand their courseware activities, two did not respond to this question.

A final aspect focused on the evaluation of (used) courseware packages. Interestingly, two institutions did not respond to this question. One mentioned that it is not known actually how courseware will be and/or is evaluated for effectiveness and/or quality. One stated that there is no special evaluation; student learning is evaluated within the lecture format - not in direct relation to the media.

3 INTERPRETATIONS AND CONCLUSIONS

About the Respondents

The first part of the survey was used to determine the characteristics of the institutions which develop and/or use courseware. Only two profit institutions returned completed questionnaires.[29] This makes a response rate of only 4,8 per cent for profit organizations! On the other hand, 50 per cent of all non profit organizations responded and returned a completed questionnaire.

It seems that profit organizations - especially in Europe - do not like and/or appreciate surveys, i.e. questions about their internal organization and procedures. The overall response rate is 28,1 per cent for the total sample. Subtracting the five profit organizations who refused to fill out the survey in detail, a response rate of only 20,3 per cent was realized for the questionnaires which were returned completed.

Instructional Factors

The second part of the survey focused on a basic list of instructional factors identified from literature. The survey revealed that the two profit organizations fully agreed on the basic list of instructional factors (without exceptions). The respondents of the non profit organizations did not fully agree on all factors. Three out of nine factors were rated on a 83,0 per cent level or higher to be necessary for effective courseware development; six out of nine factors on a 75,0 per cent level or higher. The factor "Give directions, cues, prompts which have to be available all the times" was only rated 41,7 per cent to be necessary. 33,3 per cent of the respondents thought that the description of this factor was not clear and precise enough.

30,7 per cent of the respondents believe that these instructional factors represent a good list to consider in the development of courseware. 61,6 per cent are of the opinion that there are some other factors which should be considered to develop quality courseware and therefore may discriminate between good and bad courseware. These additional factors focus on the implementation in the class room, the application of media-specific features (movement, answer, feedback), if the computer is the best media for delivery, and so forth. As we understand instructional factors to be a basic list which should be integrated in the design of courseware, questions of implementation in school and the media decision are not covered by these factors.[30] The application of media-specific features (such as movement, answer, and feedback) should be included in the factors "Use motivation and stimulation techniques" and "Provide quality interaction".
All institutions which responded to this question agree that instructional factors should be integrated in the design of courseware.[31]

To conclude: We consider the basic list of instructional factors not to be fully agreed. However, we think that the list is accepted more or less because only two factors were rated 25,0 per cent to be unnecessary. Therefore, we will concentrate our further work on a more

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[29] Seven profit organizations returned the questionnaire, but only two of them are really completed.

[30] These aspects should normally be considered in other, i.e. earlier, stages.

[31] 33,3 per cent of the respondents did not answer this question!

precise description of factors which were not strongly agreed and/or need more information to make a clearer statement.

Main Activities of Courseware Development

The survey revealed that that 50 per cent of all respondents which develop courseware cover the areas Natural Sciences, Social & Economic Sciences, and Humanities & Languages. 25 per cent have activities in two areas; 16,7 per cent in one area only. One respondent has its main activity in **another** area (Industrial Technical Training).

The Natural Sciences, such as Biology, Chemistry, Physics, and Mathematics, are strongly represented. However, Social & Economic Sciences and the Languages make a substantial part of courseware development! Tutorials and simulations are the strategies which receive most attention from developers; drills are not heavily considered anymore.

Instructional Design of Courseware

75,0 per cent of the respondents consider ideas of instructional design in courseware development. But these institutions do not take over learning theories or ISD models without adapting it to the specific situation. Therefore, it seems that each respondent has its **own** (specific) instructional design procedure(s).

To conclude: Most of the respondents include concepts, ideas and procedures of instructional (system) design in courseware development, but the various procedures have little in common!

Evaluation of Production Strategies

The survey revealed that 25 per cent of the respondents use an individual production strategy; 8,3 per cent (which corresponds to one respondent) only apply the team strategy. The other two respondents utilize both - the individual and the team strategy.

Nine institutions only employ a (sort of) team strategy (traditional team strategy and/or support strategy). The team encompasses in **all** the cases a **SME** and a **programmer**, but **not** in all cases an instructional designer, a graphics designer, and/or a project manager. **Six** of these nine consider the **team** strategy to be **more satisfactory**. The other three did not respond to this question!
The sole institution which utilizes the individual strategy did not answer this question!
Two institutions utilize both - the individual and the team strategy. One of these two states the team strategy to be more satisfactory. The other one claims that sometimes the individual strategy is more satisfactory; sometimes the team strategy (winners and losers on both).

A preceding question reveals that most of the institutions see the advantages of the individual strategy, but it is very difficult - if not impossible - to find somebody who is a SME, an instructional and graphics designer, a programmer, and a project manager in **one** person!

To conclude: Most of the respondents utilize a sort of team strategy. Moreover, most of the institutions who responded to this question consider the team strategy to be more satisfactory. The disadvantage of the individual strategy is the strategy itself - the restriction that one person should have all capabilities and skills of a team to do a good job.

Production Approaches

Five of twelve respondents tried to evaluate the capability to integrate instructional and/or pedagogic concepts, ideas and models in the production approach utilized by the institutions. The answers of the five institutions revealed that essential aspects and/or factors may be the (production) experience, the design system itself, the team strategy (i.e. involvement of specialists), and an iterative review and evaluation process throughout the development of courseware.

A special question which focused on design instruments showed that eight out of twelve developers not only use "standard instruments" such as SADT, flowcharting, storyboarding for the design, but utilize special instruments, too. Some of these specific instruments are developed inhouse; others are acquired from the market. Prototyping methods are emerging and used by some of the institutions.

Discriminating (Quality) Factors

The very heart of the survey concentrated on the question if there are factors which may discriminate between good and bad courseware related to the production system. Eleven out of twelve respondents considered one or more areas of a production system to be discriminating between good and bad courseware! The software life cycle was rated most essential.[32] Secondly, the consideration and integration of instructional and/or pedagogic concepts and ideas in courseware development and the production strategy[33] were considered to be essential. The activities of the software project management, special methods/instruments and tools, and the programming language were not considered to be as discriminating and essential. Some of the respondents even claimed that the programming language would be irrelevant, unimportant to develop quality courseware. This statement naturally stands in contrast to the discussion of utilizing an all purpose (high level) language versus authoring languages/systems.

To conclude: Given a list of options which may discriminate between good and bad courseware, the respondents vote for the software engineering, the consideration of instructional and/or pedagogic concepts and ideas, and the production strategy as essential areas. Given an open-ended question which asked for discriminating factors, a variety of factors emerged, but only a few of these factors were agreed by more than one institution, e.g. a sort of team strategy and the use of (external?) SME.

Assessment of Experiences with Other Production Systems

Five out of thirteen institutions made experiences with other production systems (strategies and/or approaches). These were individual strategies on one hand, and ISD models on the other hand. The individual strategy is seen to be problematic regarding management and software engineering; the (full) ISD process is considered to be too cumbersome.

To conclude: Most of the institutions did not answer this question and/or did not make experiences with other production systems. On the other hand, the cyclic, iterative team strategy is regarded as appro-

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[32] Within this area, the design phase and the field test/evaluation phase were rated to be most discriminating.

[33] The only significant detail result in this area was the rating of the team strategy to be discriminating.

priate solution for (large scale) courseware development by the respondents.

Aspects of Authoring Courseware

The subchapter aspects of authoring courseware focused on the following questions: Which programming languages are utilized for coding courseware? Which role play authoring languages and/or systems in courseware development?

PASCAL, C, BASIC, machine/assembly language and LOGO are the languages which are used by most respondents for courseware development. Some of the authoring languages and systems were mentioned, but they still play a minor role in courseware development for the respondents. However, there are a few institutions which develop their courseware only with authoring languages/systems.

To conclude: PASCAL, C, BASIC are the most important all purpose (high level) languages for courseware development. A few institutions utilize authoring languages/systems, but 66,6 per cent of the institutions (still?) claim that these authoring languages/system are too limiting, restrictive, and only suitable for tutorial courseware materials.

Feedback Information from Users about the Quality of Courseware

The special questions focusing on feedback information from end users about the quality of courseware revealed that there are a variety of instruments and methods which are applied. The review and evaluation forms still are the most important methods for the respondents.

Courseware Development and Use in the Future

The respondents mentioned **diverse** trends for courseware use in the future due to the situation in the instructional/training media market, the type of courseware offered on the market, the technical progress, and to financing and support of courseware. However these trends are not only diverse and offer a variety of ideas, they even are contradictory, especially concerning the situation in the media market (niche product - widespread use in industry, school and home).

The situation is a little bit different for the assessment of tools to support the development of courseware. Tools which support the rapid prototyping, as well as tools for specification, design, testing and management are considered to be important trends. On the other hand, tools of artificial intelligence were not seen to be an important trend to support the development of courseware, even not in the long range.

Aspects of Courseware Use

Only four respondents belonged to the group of courseware users. Two of the these want to expand their courseware use. The survey revealed that these users do not consider (summative) evaluations to be important (at the moment).

The use of courseware is a reflection of the production area: After the subjects of Natural Sciences (such as Biology, Chemistry, and Physics), Economics and the Languages are important subjects of courseware use.

4 SUMMARY

Though the development of courseware and its implementation in schools (especially Universities and Colleges) was initiated in the U.S.A. in the late 1950s and early 1960s, the overall quality of courseware is still mentioned to be questionable by many authors. A bunch of reasons contribute to this situation.

We believe that the **production system** has a **strong impact** on quality courseware development. One method to explore production systems for courseware development is the establishment of questionnaires which are sent to institutions which develop and/or use courseware.

This survey started in January 1987 and was called "Development of CAI Curriculum Materials". It was established within a research study (dissertation) to explore the question of (large scale) quality courseware development, offered an overview of results and an interpretation together with conclusions.

The purpose of this survey was the evaluation of quality courseware development. The survey contained five parts: **General** indications, questions of general interest due to **instructional factors**, questions for **developer(s)** of CAI materials, questions for **user(s)** of CAI materials, and finally some additional indications. Part two trough four were the main sections of this research instrument.

64 institutions in England, the Federal Republic of Germany, the Netherlands, Switzerland, and the U.S.A. were addressed. Unfortunately, only two profit institutions returned a completed questionnaire. This makes a response rate of only 4,8 per cent for profit organizations! On the other hand, 50 per cent of all non profit organizations responded and returned a completed questionnaire. The survey revealed that profit organizations - especially in Europe - did not like and/or appreciate questions about their internal organization and procedures. The overall response rate was 28,1 per cent for the total sample including the profit organizations which returned the survey uncompleted.[34]

Nevertheless, the survey revealed **interesting results** in various **fields of interest:** About instructional factors and their integration in courseware development, main activities of courseware development, instructional design of courseware, evaluation of production strategies and approaches, discriminating (quality) factors for courseware development, assessment of experiences with other production systems, aspects of authoring courseware, Feedback information from users about the quality of courseware, courseware development and use in the future, and finally about aspects of courseware use.

[34] Subtracting the five profit organizations who did not fill out the survey in detail, a response rate of only 20,3 per cent would emerge for the remaining sample.

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